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CONTROL OF APPLE MAGGOT BY POISONED BAIT SPRAY.

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BULLETIN 251

SOLUBLE POISONS IN THE POISONED BAIT SPRAY TO CONTROL THE ADULT OF THE APPLE MAGGOT (*RHAGOLETIS POMONELLA WALSH*).*

HENRY H. P. SEVERIN.†

For a period of ten years a number of Italian entomologists have been experimenting with various methods of baiting and a large number of different formulas of poisoned baits to control the olive fruit fly (*Dacus oleae* Rossi) and at present a cheap and practical remedy is used to combat this insect. After the Italian naturalists demonstrated the effectiveness of the poisoned bait, French entomologists also tested the different methods declared a success in Italy to control the olive fruit fly. After a period of five years, French scientists gave a striking demonstration of the remarkable success of the poisoned bait spray. South African entomologists, apparently unaware of the work of the Italian naturalists started in 1903, began to spray with poisoned diluted molasses to control the Mediterranean fruit fly (*Ceratitis capitata* Wied.) in the season of 1904-5. This work was carried on for a period of five years and during this time a decisive demonstration of the success of this insecticide was given under South African conditions. The same remedial measures have been adopted in other parts of the world to control the Mediterranean fruit fly.

POISONED BAIT STUDIES IN AMERICA.

Within recent years similar control measures have been started in the United States and Canada against the adult of

*Papers from the Maine Agricultural Experiment Station: Entomology No. 86.

†Member of the Station Summer Staff in 1914 and 1915.

the apple maggot (*Rhagoletis pomonella* Walsh), the cherry fruit flies (*Rhagoletis cingulata* Loew. and *Rhagoletis fausta* O. S.), the currant fruit fly (*Epochra canadensis* Loew.) and the imported onion fly (*Phorbia cepetorum* Meade). The methods adopted and the results obtained by the different investigators in the control of the apple maggot are given in the following paragraphs.

O'Kane* used a "mixture of arsenic, molasses and water distributed over the leaves of the tree," to control the apple fly in New Hampshire. "Through the coöperation of growers this plan of spraying was tried at several different points. In most the results were negative. It seems probable that in these instances the possible value of the treatment was obscured by the proximity of other infested trees not so treated. Also owing to the pressure of other work the grower was unable to apply the spray as often as would be needed in order to keep the poisoned sweet ready for the flies throughout their egg-laying season. In one instance, however, the treated tree stood alone, and this tree was given repeated sprayings as primarily planned. The variety was August Sweet and the fruit had been worthless for years. This tree yielded this season practically perfect fruit."

An experiment to combat the apple fruit fly with the poisoned bait spray, was conducted at the Maine Agricultural Experiment Station. Johannsen and Patch† write, "Our own experiments made this season upon two Tolman Sweet apple trees, using a spray of arsenate of lead and brown sugar in solution gave discouraging results."

During two seasons, Illingworth‡ experimented with the poisoned bait spray to control the adult of the apple maggot in New York. In the season of 1911, the larvæ were already at work in the Primate apples when he began to spray. "Sweetened arsenate of lead proved effective but was rather slow." Quick results were desired, and potassium arsenate, a soluble poison, was used together with syrup diluted with water. Illingworth (1912, p. 165) observed that the trypetids fed on the sprayed fruit shortly after the application of the spray. These

*New Hampshire Station Bul. 151, pp. 42-44.

†Maine Station Bul. 195, p. 238.

‡New York (Cornell) Station Bul. 324, pp. 126-187.

flies were collected in jelly-glasses, where they became paralyzed in about fifteen minutes and in half an hour they were dead.

An application of the bait containing the soluble poison was made on July 22 and 26, a pint being sprayed upon the lower branches of a 20-years-old Maiden Blush tree. In a table the author gives a daily record of the drops from this treated tree and the number of larvæ which bored out of the fallen fruit. All the windfalls picked up under the baited tree after August 15, were absolutely free from larvæ. From an untreated tree of the same variety in another field, 180 drops were gathered on August 23, and from these, larvae emerged during September. On the other hand, 115 drops collected on the same date from the treated tree failed to show a trace of a single maggot. "Hence it is quite evident that the flies deposited no eggs in the fruit of the sprayed tree after the application of July 26."

In the season of 1912, Illingworth used arsenate of lead and molasses diluted with water. On July 3, Red Astrachan trees received the first treatment. Five applications of the spray were made during the season. "On August 5, the Red Astrachan apples were ripening and showed no trace of the maggots."

"Slight difficulty was experienced in controlling the flies on a seedling variety of sweet apples," due to showers which came up nearly every afternoon during the period that the fruit fly remedy was being applied to the tree. "Even in this case, however, the fruit was vastly improved over former years." No mention is made of the number of trees treated and no check or control trees were used in 1912.

Ross* "tested two spray mixtures, one composed of arsenate of lead, glycerine and molasses and the other of Paris green, glycerine and molasses, but neither yielded satisfactory results," in the control of the apple fruit fly in Ontario.

For a period of three years, O'Kane† tested the poisoned bait to control the apple trypetid in New Hampshire. His records are taken for the most part from typical lots of sprayed trees, of which surrounding conditions were accurately known. Such field tests as are recorded consisted of two trees treated with the poisoned sweet in the season of 1910, three trees in 1911

*Ent. Soc. of Ontario. Report 1912, pp. 67-72.

†New Hampshire Station Bul. 171, pp. 1-120.

and ten trees in 1913. In the above spraying experiments, different proportions of arsenate of lead and molasses diluted with water were employed. The results are given in the table which follows.

Table showing the number of applications of the spray, the variety of apple trees, and the per cent of apples free from egg punctures on the sprayed trees and on such check or control trees as were used.

Applications of spray.	Varieties of Apples.	Apples free from egg punctures on sprayed tree.		Apples free from egg punctures on check tree.	
		Drops.	Picked.	Drops.	Picked.
	1910	%	%	%	%
3	Winter Sweet	14 (dr	ops or pick	ed?) .5	
4	President	0	8.1		
	1911				
10	Granite Beauty	55.8		52.7	
7	Sops-of-Wine	55.8	46.1		
9	Porter	46.4	59.		
	1913				
5	Porter	39.3	74.7	22.6	32.8
7	Porter	.....	0	*8.5	*.8
4	Williams Favorite	.....	3.7		
4	August Sweet	.....	11.7	.....	3.5
7	Fameuse	0	15.6		
7	Porter	.....	11.9	0	
7	Porter	.4	9.	0	
10	Grimes Golden	.....	34.8	.....	68.9
10	Grimes Golden	.....	27.9	.....	68.9
10	Grimes Golden	.....	87.3	.....	68.9

* Indicates that an "unknown sweet" was used as a check for the Porter.

The author summarized the above results as follows: "Poison bait sprays, as so far devised, have entirely failed to insure protection of the fruit of the sprayed trees from attack by the maggot. In part of the experiments there was apparently some improvement of the fruit, especially in isolated trees. This may have resulted from the death of flies because of the spray; or it may have been due to various other factors. The important point is that no such protection was forthcoming as would be essential if the treatment were to be ranked as an effective means of control."

"The above conclusions should not be taken as asserting that no flies are poisoned by such sprays. Some flies may be. In-

deed it may be, as will be noted later, that with ordinary spraying of apple trees with a simple solution of arsenate of lead and water for some other insects, such adults of the apple maggot as chance to feed or drink at spots where poison has persisted may be killed. The conclusion offered is that the adults are not materially attracted to the bait, and that such sprays, or any others so far devised, are without any adequate avail as definite and sufficient protection of the fruit, in the absence of other treatment."

Investigations Here Reported.

In our work in Maine not only were the entire orchards sprayed but also apple trees in surrounding fields and dooryards. An attempt was also made to control the apple maggot under town conditions. In the season of 1914, different kinds and amounts of poisons were employed in the bait in spraying the various orchards and the apple trees in the residential section; whereas, in the season of 1915, but one formula was used in treating the same trees. Before giving the details of the work in each season, the results of a number of preliminary experiments will follow.

DATES OF EMERGENCE OF FLIES.

The dates of the first and last emergence of the pest have an important bearing on when to make the first and possibly the last applications of the poisoned bait spray. In the season of 1914, the dates of emergence of the apple fruit flies were determined under orchard conditions; whereas, in the season of 1915, similar records were obtained in the residential section of Orono. Ground cages were placed on the sod or soil below apple trees. Soil was banked and tamped around the bottom of each cage to prevent the escape of any of the flies. During the season the vegetation which sprouted beneath the cages was cut with a sickle from time to time. Spiders and predacious insects were removed from the cages as soon as they were noticed. The records of the emergence of the adults, the maximum and minimum temperature and precipitation in the season of 1915 are given in the following table:

Dates of Emergence of Flies, Temperature and Precipitation in 1915.

Date.	Number of flies.	Maximum temperature.	Minimum temperature.	Precipitation.
July 15	1	80	56	
16	0	83	58	
17	0	78	57	.11
18	9	76	60	.24
19	0	89	51	
20	1	81	59	
21	2	84	55	
22	14	83	49	
23	9	82	56	
24	11	81	49	
25	5	79	51	
26	5	79	57	
27	0	82	62	.35
28	6	85	56	
29	0	83	58	.47
30	0	73	58	
31	6	76	60	
August 1	2	83	62	
2	0	79	62	.64
3	3	75	48	.05
4	0	78	50	
5	2	72	46	.04
6	0	80	67	
7	0	78	55	.10
8	0	73	58	
9	1	77	58	
10	1	69	60	.17
11	0	85	52	
12	0	89	58	
13	0	87	62	.40
14	1	82	63	

In the season of 1914, the first fly issued on July 20, and the last on August 15, under orchard conditions and on July 17, one specimen was found dead below a baited plum tree in the residential section. In the season of 1915, the first trypetid emerged on July 15, and the last on August 14, under town conditions. From these records it is evident that the first application of the poisoned bait spray should be made on July 15, and the last treatment on August 15, providing that the adults, which probably live until the apples are harvested, do not invade the sprayed area from neglected trees.

EXPERIMENTS WITH KINDS AND AMOUNTS OF POISONS.

In view of the fact that a number of entomologists advocate the use of soluble poisons in the bait to control various species of Trypetidae, we conducted a series of experiments with different kinds and amounts of poisons to control the apple fruit fly. In Italy and France soluble poisons, such as potassium or sodium arsenite and sodium arsenate, were used in a large num-

ber of different formulas of the poisoned bait to control the olive fly (*Dacus oleae* Rossi). In 1911, Illingworth used the following "fly destroyer" as given by Merck to control the adult of the apple maggot in New York:

Syrup	4 parts	or 4 pts.
Potassium arsenate ...	1 part	or 1 lb.
Water	45 parts	or 45 pts.

In 1912, Illingworth used the following formula:

Molasses	1 lb.	or 25 lb.
Arsenate of lead	3 oz.	or 5 lb.
Water	4 gal.	or 100 gal.

The author states that, "If the conditions are such that the flies do not succumb readily to this treatment, the use of the soluble potassium arsenate is advisable as previously described."

To determine the effectiveness of different amounts of various kinds of soluble poisons used in the bait, and the extent of injury to the leaves and fruit, a number of preliminary experiments were performed. With each formula that was used, cheese cloth was fastened to the ground with spikes below a sprayed tree, so that the insects which succumbed to the effects of the poisoned sweet and dropped from the tree, could be detected more easily on a white background. By gathering the dead specimens daily, we endeavored to determine how long the spray was effective after different amounts of rainfall, and thus secure a clue as to the minimum number of applications necessary to insure good results.

Experiment I. In the first experiment one each of the following apple trees, Duchess, Fameuse, McIntosh Red, Tolman Sweet and three plum trees were treated with the fruit fly remedy, which was prepared according to the same formula Illingworth used in 1911. One pint to two quarts of the insecticide, depending upon the size of the tree, was applied to the foliage and fruit on July 11. The sprayed leaves on all of these trees were scorched and on July 16, some of these leaves began to drop. The fruit was examined from time to time and occasionally traces of burning was found but this was especially marked with the Duchess. A large number of dead

moths, flies, ants, occasionally hymenopterous parasites, beetles, etc., were picked up daily on the cheese cloth, and then the leaves, bits of bark, twigs and wind-falls were swept off with a broom. Rain fell on July 11, 12 and 19, amounting to a total of 1.12 inches. On July 16 and 17, the fogs were so heavy that droplets of water dripped from the wet leaves and probably washed off some of the bait. On July 19, eight days after the application of the spray, no dead insects were found on the cheese cloth and the bait was now considered ineffective.

Experiment II. In the second experiment instead of one pound of potassium arsenate, one-half pound was used, the proportions of the other ingredients being the same as in Illingworth's formula of 1911. On July 11, one pint of the poisoned bait was sprayed on the foliage of the lower branches of a large Tolman Sweet. The results of the first experiment were practically the same as in this second experiment.

ORCHARD EXPERIMENTS WITH POISONED BAIT.

In order to give the various soluble poisons such as potassium arsenate, sodium arsenate and sodium arsenite a most thorough test under orchard and residential conditions, it was decided to use 3-4, 1-2 or 1-4 of an ounce of these insecticides to every three gallons of water and one pint of molasses. The different kinds and amounts of soluble poisons burned the leaves, some of which finally turned yellow and dropped from the trees. Some of the owners were considerably alarmed on account of the scorching of the leaves of their apple trees and we were compelled to discontinue the use of soluble poisons and substitute insoluble arsenicals. A remarkable peculiarity was the fact that rarely was a dead specimen collected from the cheese cloth with the use of Paris green or arsenite of lime in the bait, and we are inclined to believe that the explanation rests in the ability of some insects to strain out particles of insoluble poisons from the diluted molasses. During the two seasons cheese cloth was fastened to the ground below 29 apple trees sprayed with different quantities of soluble or insoluble poisons in diluted molasses, but not a single honey bee was found among the dead insects. As no conclusion can be drawn on the effectiveness of the poisoned bait, due to the fact that a

soluble poison was used in one or more applications of the spray and an insoluble arsenical in the other treatments, only such details of the work of 1914, worthy of mention will be taken up in the following discussion of the season's work of 1915.

Experimental area. As the poisoned bait has been found to be more effective in the control of other species of Trypetidae in a well isolated orchard or in a large isolated area composed of many non-isolated orchards, a description of the location of our experimental area is necessary. A glance at the map shows that all of the apple trees indicated by dots were isolated on one side by the Penobscot river, and a bay of this river, but on the other sides apple trees were sometimes found at short distances from the margin of the experimental area. A more careful examination of the map shows that there are six orchards indicated by the following figures which represent the number of trees in each orchard: 84, 31, 40, 57, 47 and 38. The principal part of each orchard is situated above the figures. A series of dashes indicates the boundary between two orchards or separates an orchard from trees present in adjacent dooryards. The residential district contained 274 apple trees scattered in the different yards. The entire area covered about one square mile and contained a total of 571 apple trees.

Since we bred the apple fruit fly from haws gathered near Orono, Maine it was decided to spray all of the hawthorns near the orchards, and also those located on a hillside along the bay of the Penobscot river. Seedlings and crabapple trees near the orchards were also baited.

Care of orchards. The orchard which contained 84 trees was sprayed on May 4, 1914, with Scalecide to control the oyster-shell scale. Seventy-five gallons of spray containing 4 1-2 gallons of scalecide were used. On May 23-25, a combination spray consisting of dry powdered arsenate of lead and lime-sulphur was applied to control the tent-caterpillar, codling moth and fungous diseases. On July 8, the combination spray was again applied. Seventy-five gallons of the following formula were used with each application of the spray:

Dry powdered arsenate of lead..	1 1-2	lb.
Lime-sulphur	1	gal.
Water	50	gal.

In 1915, two applications of the combination spray were made as in the previous year. The orchard was plowed once during June and received no further cultivation during the entire season. The drops were allowed to remain on the ground, and an examination of this orchard in April, 1914, showed numerous rotted apples below the trees.

A general infestation of the apple maggot had occurred throughout this orchard during 1913, and all of the different varieties of apples had been attacked by the pest. The most seriously infested variety, however, was the Tolman Sweet.

None of the other orchards had been sprayed for the control of insect pests and fungous diseases. The owners stated that they had been troubled for a number of years with the railroad worm and that the drops had been allowed to decay on the grass in previous years.

Poisoned bait formula. In 1915, the following formula of the poisoned bait was used in spraying the six orchards and the apple trees in the residential section:

Potassium arsenate 3-4 oz. (dissolved in boiling water)	
Molasses	1 pt.
Water	3 gal.

The solution was prepared by stirring the molasses in three gallons of water until all of the molasses on the bottom of the pail was dissolved. The potassium arsenate was first dissolved in about a quart of boiling water and was then added to the diluted molasses. The poisoned bait was thoroughly agitated by pumping the liquid back upon itself with a spray pump.

Application of Poisoned Bait. The poisoned bait was applied with a common, garden, brass spray-pump provided with a rose sprinkler nozzle, which throws a mist-like spray. A different method was employed in applying the insecticide in each season. In 1914, the man applying the spray walked rapidly around the tree, a yard or more away from the ends of the lower outermost branches, and at the same time the poisoned liquid was forced from the pump, into the air toward the top of the tree. The minute drops fell over and into the tree resulting in an even distribution of the droplets, for the most part on the upper surface of the leaves. The dose per tree varied from a half pint to a quart depending upon the size of

the tree. In 1915, the fruit fly remedy was applied to the trunk, large limbs and foliage of the lower branches. The man faced the trunk of the tree and applied the bait, then he turned his back toward the trunk, walked around in a circle and at the same time forced the poisoned sweet from the pump over the large limbs and foliage of the lower branches. Those droplets which strike the foliage adhere for the most part to the lower surface of the leaves, where rains are not so apt to wash off the spray.

The following table shows the dates of the applications of the poisoned bait and the number of gallons of spray material used in the various orchards and the residential district in 1915.

Dates of Applications of Spray and Number of Gallons Used in 1915.

Dates of Applications of Spray.	Number of trees in orchards.						Residential district.	Total gallons.
	84	31	40	57	47	38	274	
July 16	.....	.....	.....	.....	.....	.....	12	12
19	.....	4	7	7	5	.....	.....	.....
20	14	.....	.....	.....	.....	.....	.....	.....
21	.....	.....	.....	.....	.....	4	26	67
August 3	.....	3	3	6	6	3	.....	.....
4	12	.....	.....	.....	.....	.....	27	60
16	...	3	3	6				
19						4	26	
20	12	.....	.....	.....	5	.....	.....	59
	38	10	13	19	16	11	91	198

Spray injury from Poisoned Bait. The orchards containing 31 and 40 trees were sprayed with eleven gallons of the bait in the first application, but in the second and third treatments the amount of spray material was reduced to six gallons. Tent-caterpillars had practically stripped the leaves from some trees, while others were partially defoliated, and as the partly devoured leaves dropped very readily due to the scalding of the soluble poison in the diluted molasses, it was deemed advisable to reduce the amount of spray material in the second and third baitings.

In 1914, a number of complaints were made on account of the scorching of some of the leaves, which later turned yellow and finally dropped from the trees. In some of the dooryards

we were forced to stop spraying before the end of the season due to the scalding of the leaves, while in other yards and in the orchards it was decided to discontinue the use of soluble poisons and substitute insoluble arsenicals. In visiting the owners during the next season, however, they were so delighted with the crop of sound apples obtained in the previous year, that they promptly forgot all about the alarm created by the partial defoliation, and without exception, permission was granted to spray the apple trees again. Nevertheless, during the second season the fear of some injurious effect of spray injury to the trees was voiced repeatedly. Many people, however, preferred sound fruit even if burned foliage was the necessary price. Raking the leaves from well kept lawns where apple trees were growing proved to be a troublesome task.

Effectiveness of poisoned bait. An attempt was made to determine how long the poisoned bait would remain effective after different amounts of rainfall. After each treatment, cheese cloth was fastened to the ground with spikes below a sprayed tree. The insects which succumbed to the effects of the soluble poison in the sweet were collected daily from the cheese cloth and it was reasonable to suppose that the insecticide became ineffective due to rains when no dead specimens were found. As the records on precipitation at the University of Maine were taken at a distance of about two miles from our experimental area, no accurate statement can be made as to the amount of rainfall required to wash off all the bait. It is evident, however, that an "all day rain" with heavy intermittent showers will destroy the effectiveness of the fruit fly remedy In view of the abundance of rain in the season of 1915, the effectiveness of the poisoned diluted molasses was put to a most thorough test.

An experiment was performed in the field to determine the length of time required for the amount of poison used in the formula in 1915, to kill the adults. A tall Benoni apple tree (Map, L) received the fourth treatment on August 19, at 3.30 P. M. and on August 20, at 7.30 A. M. six female and four male apple fruit flies were collected on the cheese cloth sixteen hours after the application of the bait. Four specimens feeding on the insecticide on the upper surface of the leaves were captured, but all died in captivity within two days. On August

21, two days after spraying, one dead fly was picked up on the cheese cloth and on August 24, the last trypetid was found, but due to heavy rains during the preceding day we were unable to visit the tree. A light shower of rain fell on August 22, but heavy rains fell during the night and continued throughout the next day. The precipitation amounted to 1.58 inches on August 23, and the last baiting in the entire experimental area became ineffective after this date.

We have already called attention to two different methods of applying the spray. After the above Benoni tree received three applications of the bait, by spraying the trunk, larger limbs and foliage of the lower branches, 88 per cent* of the apples were found to be infested on August 19. On this same date, the fourth treatment was given by forcing the poisoned sweet from the spray pump into the air toward the top of the tree, so that the minute drops fell over and in the tree. On September 2, 49 per cent* of the apples were maggoty and on September 22, 15 per cent* were infested. In all probability, a general distribution of the fruit fly remedy over the foliage is more effective than spraying the trunk and large limbs due to the fact that the bark seems to absorb the poisoned diluted molasses. After the water has evaporated, a glossy layer of molasses adheres to the upper surface of the leaves, while the hairy coating of the lower epidermis prevents the formation of this film of sweet and seemingly absorbs a considerable amount of the poisoned liquid.

Attraction to poisoned bait. One observation tends to show that the apple fruit fly is attracted to the poisoned bait under field conditions. A specimen was observed at rest on an apple just at the time that the spray was about to be applied to the tree. Suddenly the fly took wing and came to rest on my hand which was spattered with the bait and here it began to feed. The distance from the apple to my hand was about a yard.

Checking up results. In checking up the effectiveness of the poisoned bait spray, the apples were picked at random from a treated tree in the various orchards or residential district and on the same day apples of a similar variety were gathered from

*This sequence of per cents is of course only possible where the infested fruit is dropping and the counts taken each time from fruit remaining upon the tree.

an untreated tree in other orchards or another section of the residential district, at a distance varying from about 1,000 feet to two miles. Some varieties of apples were kept in the insect-house for a month or more so as to give any eggs that were deposited shortly before picking an opportunity to hatch and also to bring out more conspicuously the tiny tunnels of the recently hatched larvæ in the pulp. Each apple was cut in half and if there was no evidence of an infestation, the halves were thinly sliced to determine whether there was any trace of the conspicuous brown tunnels of the larvæ in the pulp. In this way a record was taken of the infested and non-infested apples. No attention was paid to egg punctures as the apple fruit fly will sometimes make an egg puncture and not deposit an egg.

RESULTS IN ORCHARDS.

The following table shows the per cent of apples infested on the sprayed and check trees in 1914 and 1915, the dates on which the apples were picked, the location of the treated trees on the map in the orchards and the varieties of apples:

Results of Two Seasons' Spraying in Orchards.

Varieties of Apples.	Map.	Picked, 1914.	Picked, 1915.	Apples infested on sprayed tree.		Apples infested on check tree.	
				1914.	1915.	1914.	1915.
				%	%	%	%
Tolman Sweet*	T1	Sept. 19	Sept. 27	4	5	96	100
Tolman Sweet	T2		Sept. 27		3		100
McIntosh Red	D1	Sept. 19	Sept. 24	0	0	28	.....
McIntosh Red	D2	.....	Sept. 24	.....	1	.....	.....
Fameuse	F1	Sept. 29	Sept. 27	0	6	38	52
Fameuse	F2	.....	Sept. 27	.....	2	.....	52
Milden	M1	Sept. 12	Sept. 29	0	2	92	25
Milden	M2	.....	Sept. 29	.....	4	.....	25
Pyrus prunifolia (Hybrid crab)	P	.....	Sept. 17	.....	7	.....	.....
Rolfe*	R	Sept. 14	Sept. 8	14	1	.....	.....
Hyslop crab	H	.....	Sept. 17	.....	24	.....	1
Large Red Siberian	S	.....	Sept. 17	.....	0	.....	.....
Bells Early*	B	Sept. 26	Sept. 12	55	20	.....	.....
Tolman Sweet*	T3	Sept. 26	Sept. 27	40	3	100	100
Alexander		Sept. 14		24		97	.....
Tolman Sweet	T4	.....	Sept. 27	.....	34	.....	100
Fameuse		Sept. 19		4		.....	.....
Wealthy	W		Sept. 24		57	.....	.....
Tolman Sweet	T5		Sept. 27		32	.....	100

* Indicates that the apples were picked from the same sprayed tree during 1914 and 1915, while the varieties not so marked were picked from different trees during the two seasons.

It is evident from this table that in the orchard which contained 84 trees (Map, 84) the results show practically no infestation in the season of 1914. From time to time during this season, the drops of different varieties of apples were gathered, but among the windfalls, only one infested Tolman Sweet apple was found. The Tolman Sweets in this orchard had been badly infested for a number of years. In 1913 no Tolman Sweets escaped infestation. In 1914 and in 1915 the apples were practically free from the railroad worm. In view of the fact that the pest was almost completely controlled in the season of 1914, we are hardly justified in drawing conclusions from similar results obtained in 1915; because since maggots were not present the fall of 1914 we should not expect to have flies the next summer.

No definite conclusions can be drawn from the results obtained in the two orchards containing 31 and 40 apple trees (Map, 31 and 40), due to the fact that no check or control trees of the same variety as the treated trees could be obtained. In 1914, 14 per cent of the Rolfe (Map, R) were infested; whereas, in the season of 1915, the infestation on this same tree was reduced to 1 per cent. In the season of 1914, there was a heavy crop of apples, while in the following season there was an exceedingly short crop and one would naturally expect a heavier infestation.

Definite conclusions, however, can be drawn from the results obtained in the orchard containing 57 trees (Map, 57). A Tolman Sweet tree (Map, T3) showed an infestation of 40 per cent after the first season's baiting and 3 per cent after the second season's treatment, while the check tree showed 100 per cent maggoty fruit. A Bells Early (Map, B) showed an infestation of 55 per cent and 20 per cent during the two seasons. The Tolman Sweet and Bells Early trees were by no means stripped of their fruit in the season of 1914, since only 100 apples were picked of each variety for examination in each year. It must be noted, however, that the Tolman Sweet tree was sprayed by forcing the poisoned bait into the air so that the minute drops fell over and into the tree, while in the case

of the Bells Early tree the insecticide was applied to the trunk, large limbs and foliage of the lower branches.

The orchards containing 47 and 38 trees were within 100 feet of other untreated orchards and apple trees in dooryards, and the higher infestation is seemingly due to the invasion of the apple fruit flies. A Tolman Sweet tree in each orchard (Map, T4 and T5) showed that 32 per cent and 34 per cent of the apples were infested compared with 100 per cent maggoty fruit on the control or check trees. A Wealthy (Map, W) showed that 57 per cent of the apples were infested and this represents the highest infestation under orchard conditions in the season of 1915.

RESULTS IN RESIDENTIAL DISTRICT.

Lounsbury* of South Africa, demonstrated that the Mediterranean fruit fly can be controlled with the poisoned bait spray under town conditions even where summer rainfall is heavy. We, therefore, decided to test the value of the poisoned sweet as a means of combating the apple fruit fly in the residential section of Orono, Maine. The residential district in the experimental area contained 274 apple trees scattered in vacant lots and dooryards.

Some of the occupants informed us that certain varieties of apples had been seriously infested by the apple maggot for ten years. In some yards all of the infested fruit was allowed to decay on the ground, and in others, some or all of the drops had been gathered during previous years. Poultry was fenced off in some of the back yards below the apple trees and in others, the fowls were allowed to run at large.

The following table shows the results of two seasons' spraying in the residential district:

Results of Two Season's Spraying in Residential District.

Varieties of Apples.	Map.	Picked, 1914.	Picked, 1915.	Apples infested on sprayed tree.		Apples infested on check tree.	
				1914.	1915.	1914.	1915.
				%	%	%	%
McIntosh Red	D3	.....	Sept. 24	.....	49	.....	0
Coles Quince†	C	Sept. 17	Sept. 17	34	4	.....	.....
Munson Sweet†	U1	Sept. 8	Sept. 2	96	91	99	100
Alexander	A	.....	Sept. 22	.....	64	.....	4
Transcendent crab	K1	.....	Sept. 17	.....	97	.....	100
McIntosh Red	D4	Sept. 14	Sept. 24	14	16	.....	0
Bellflower	X	.....	Sept. 27	.....	41	.....	.....
Tolman Sweet	T6	.....	Sept. 27	.....	24	.....	95
Tolman Sweet	T7	.....	Sept. 27	.....	50	.....	95
Tolman Sweet	T8	.....	Sept. 27	.....	46	.....	95
Tolman Sweet	T9	.....	Sept. 27	.....	88	.....	95
Munson Sweet†	U2	Sept. 14	Sept. 2	99	98	.....	100
Transcendent crab	K2	.....	Sept. 9	.....	80	.....	100
Fameuse	.....	Sept. 14	.....	84	.....	.....	.....
Fameuse	.....	Sept. 14	.....	54	.....	.....	.....
Fameuse	.....	Sept. 14	.....	11	.....	.....	.....
Golden Russet	.....	Sept. 14	.....	13	.....	.....	.....
Duchess	.....	Sept. 14	.....	13	.....	.....	.....
Seedling	.....	Sept. 17	.....	73	.....	.....	.....

*Agr. Jour. Union of South Africa, No. 25, pp. 1-7.

† Indicates that the apples were picked from the same sprayed tree during 1914 and 1915, while the varieties not so marked were picked from different trees during the two seasons.

It is evident from the results recorded in this table that the control of the apple fruit fly with the use of the poisoned bait has been a complete failure in the residential district. Two Munson Sweet trees (Map, U1 and U2) showed an infestation of 96 per cent and 99 per cent of the fruit after the first season's spraying compared with 91 per cent and 98 per cent after the second season's treatment. In the case of a Coles Quince (Map, C), however, there was a decided improvement of the fruit, 34 per cent being attacked in 1914, and 4 per cent in 1915. A comparison of the infestation of a treated McIntosh Red and Alexander (Map, D3 and A) with the check trees shows a higher per cent of maggoty fruit on the sprayed trees. On the other hand, four Tolman Sweet trees (Map, T6, T7, T8, and T9) showed an infestation of 24, 46, 50 and 80 per cent compared with 95 per cent on the check trees.

Attention must be called to the severe infestation of fruit on treated trees situated in dooryards in close proximity to Professor Woods' orchard (Map, 84) in which there was practically no infestation during the past two seasons. Situated within 450 feet of this orchard were the following varieties of apple trees showing a high per cent of infested fruit: Tolman

Sweet (Map, T9) 88 per cent; Munson Sweet (Map, U2) 99 per cent in 1914, and 98 per cent in 1915; Transcendent crab (Map, K2) 80 per cent and Benoni (Map, L) 88 per cent on August 19.

It is reasonable to suppose that when badly infested early varieties are harvested, such as the Transcendent crab and Munson Sweet, that the absence of apples on the trees will cause the female flies to seek other fruit in which to oviposit. The Transcendent crabs and the Munson Sweets were harvested by the middle of September. It must be noted that the last application of the spray in the orchards and residential district were made between August 12 and 22, during the two seasons. The bait was washed off by rains before the early varieties had been harvested, leaving the fruit trees unprotected, at the time when the dispersal of the flies probably occurs.

CONCLUSIONS.

In 1914, no conclusions could be drawn on the effectiveness of the poisoned bait spray from any of the experiments that we performed, due to the fact that the different soluble poisons scorched the leaves and therefore insoluble arsenicals were substituted in the later treatments. A series of experiments with different amounts of soluble poisons, such as potassium and sodium arsenate and sodium arsenite, show that as small a quantity as one-quarter of an ounce of these insecticides dissolved in boiling water and then added to three gallons of water with one pint of molasses will burn the foliage of the apple trees.

In 1915, during a very rainy season, the results obtained with three applications of the poisoned bait spray containing a soluble poison dissolved in diluted molasses, showed that the infestation varied from 0 to 20 per cent in orchards situated away from the margin of the experimental area, and from 32 to 57 per cent in orchards near untreated trees. An even distribution of the droplets over the foliage is more effective than spraying the trunk, large limbs and foliage of the lower branches. The number of applications necessary to insure good results can not be stated with this work still in its experimental stage. In orchards where tent-caterpillars have practically stripped or partially defoliated the trees the poisoned bait with

the use of a soluble poison can not be advocated. In orchards where tent-caterpillars are controlled, defoliation caused by spray injury is far less than the damage caused by these pests in neglected orchards. Our experience shows that after fruit growers have been convinced of the results obtained by the use of the poisoned bait spray, many prefer sound fruit even if burned foliage is the necessary price.

The fruit fly remedy has been a complete failure in the control of the pest under town conditions. With four applications of the spray the infestation varied from 4 to 98 per cent.

Explanation of Map.

Map showing the location of the experimental area in which an attempt was made to control the adult of the apple maggot by means of the poisoned bait spray under orchard and town conditions. The apple trees indicated by dots on the map were isolated on one side by the Penobscot river and a bay of this river. The location of six orchards are shown by the following figures which represent the number of trees in each: 84, 31, 40, 57, 47 and 38. The principal part of each orchard is situated above the figures. A series of dashes represents the boundary between two orchards or separates an orchard from trees present in adjacent dooryards. The residential district contained 274 apple trees scattered in the different yards. The entire area covered about one square mile and contained a total of 571 apple trees.

A circle surrounding a dot shows the location of a sprayed tree which was checked up with an untreated or control tree situated on the outside of the experimental area. The following is a list of varieties of apples that were used in checking up the results:

A = Alexander.
B = Bells Early.
C = Coles Quince.
D1-D4 = McIntosh Red.
F1-F2 = Fameuse.
H = Hyslop Crab.
K1-K2 = Transcendent Crab.
L = Benoni.
M1-M2 = Milden.
P = Pyrus prunifolia (Hybrid Crab).
R = Rolfe.
S = Large Red Siberian Crab.
T1-T9 = Tolman Sweet.
U1-U2 = Munson Sweet.
W = Wealthy.
X = Bellflower.

For Explanation of Map see Preceding Page